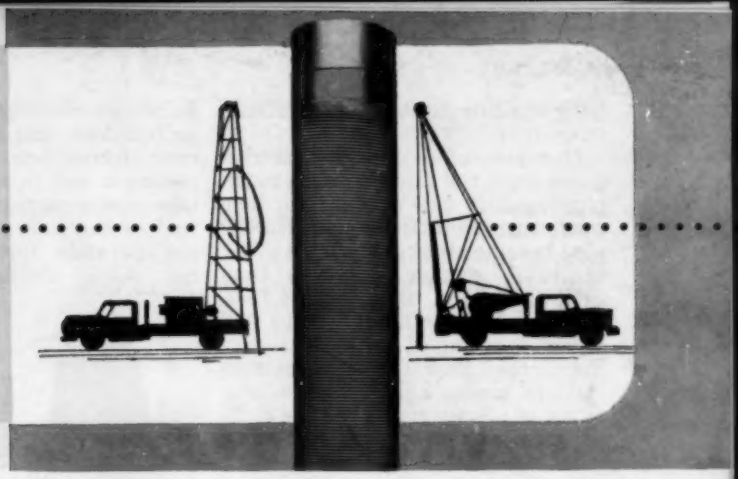
The Johnson National DRILLERS JOURNAL



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ROTARY DRILLING
BASIC WORKING PRINCIPLES

HISTORICAL

Hydraulic rotary drilling has been used for sinking shallow water wells through clay and sand formations since long before the turn of the century. In 1901, however, this method was first successfully used in deep-well drilling near Beaumont, Texas, for sinking oil wells where other methods of drilling had failed. Rotary drilling immediately thereafter became a great factor in developing the Texas oil fields. Machinery was improved by leaps and bounds until we have today's oil-field drilling equipment with almost limitless capacity.

The rotary drilling outfits used for water well work up until as late as the 1920's differed in important respects from the present-day machines. Originally, a four-post wood derrick was employed, requiring several days for erection.

The rotating table (commonly called the "whirler") was centered under the derrick and was set on tool-steel rollers. Usually, the pipe to be used as well casing also served as the drill pipe. A toothed cutting shoe was provided at the lower end of the first joint, and the casing was fed through a central opening in the rotary table. Special devices on the turntable gripped the pipe to rotate it and, at the same time, allowed it to move downward as drilling went along.

The toothed cutting shoe loosened and broke up the earth materials being penetrated. Obviously, this system was suited only to drilling through fairly soft formations.

The top of the casing was provided with a special cap that connected to the bottom of a water swivel. The top of the swivel was connected to a slush pump by a flexible hose. Water for drilling was thus pumped through the water swivel into the top of the casing and down inside the casing under pressure. The water flowed out under the toothed shoe and upward outside the casing, between it and the wall of the hole, carrying the cuttings to the surface. As drilling proceeded, the water would hold in suspension some of the clay from the formations penetrated and a thin drilling mud would result.

When the top of the casing moved down to within a foot or so of the revolving table, another length of casing was connected to the string. The new length was usually made ready for attachment ahead of time by having a second water swivel already connected. In this way, circulation of the drilling

Rotary drilling machine of the Frederickson Well Company, Hutchinson, Minnesota, drilling a 12-inch well, 237 feet deep, for the Hutchinson Co-operative Creamery. A test hole was first drilled with this equipment to get samples of the water-bearing sand and determine its depth and thickness. A 12-inch Johnson Everdur Well Screen, 30 feet long, with No. 80 slot openings was set and after development, using compressed air, the well was test-pumped at 2000 gpm.

fluid was interrupted only a minute or two.

One size of casing was carried down until the friction of so much pipe against the wall of the hole made turning difficult, or until the pipe became stuck from some other cause. A smaller size was then used until it, in turn, became fast. When it became necessary to pull an entire string of casing to change the toothed shoe, the driller always risked a caving hole since the technique of proper control of the drilling mud to prevent caving was as yet unknown.

Little progress was made in the development of rotary drilling machines for water wells until the 1930's. By that time, shot-hole drills for seismographic work in the oilfields began to find secondary use for drilling small diameter water wells. Actually, however, it has been during and since World War II that truck-mounted, portable drills with certain features to make them well-suited to the drilling of water wells in glacial drift and alluvial formations have enjoyed more attention from water well drillers in a number of areas.

Shot-hole machines lacked the ability to drill a sufficiently large range of hole sizes for water well work. Generally, the mud pump and the drill pipe were too small for the volume of drilling fluid that had to be circulated to permit drilling even 8-inch or 10-inch holes efficiently.

During the last fifteen years, several manufacturers have made significant developments in designing machines adapted to water well drilling. A goodly number of drilling contractors now operate modern rotary equipment. So far most rotary drilling for water wells is done in glacial and alluvial formations where well screens are required for the proper completion of the wells.

FEATURES OF ROTARY DRILLING

Drillers and drilling machine manufacturers argue long and loud about the relative merits of the rotary, cable-tool and other methods of drilling. Each has its advantages and disadvantages. No one goes so far as to say that any one method is the most efficient in drilling every kind of geological formation or in every area throughout the country.

Rotary methods make possible faster drilling in unconsolidated formations, except in heavy gravel or boulders, and in some types of rock formations. However, completing a well in a rotary hole may take more time and thus offset part of the time saved in the drilling operation. Rotary methods permit deeper drilling in unconsolidated formations without reduction in size of hole because pipe friction in the ground is not a limiting factor. In general, drilling of the deeper holes in glacial drift and alluvial formations can be done at less cost by rotary methods. This advantage makes it possible to do certain jobs of exploration drilling with rotary equipment that would not be at all feasible by cable-tool methods; test drilling at a number of places to locate the greatest thickness of a sand stratum is an example.

Typical three-way drag bit. Note the position of the drilling fluid nozzle in front of one of the cutting edges.

Photo courtesy Geo. E. Failing Co.

Under certain conditions, the cost of drilling larger diameter holes does not go up in the same proportion as it does in cable-tool work. This means that where favorable conditions exist, the larger diameter wells can be drilled more economically by rotary methods.

Each method of drilling, however, has its place. No single type of drilling machine has been devised yet that will work best in every formation. It is still true, too, that economical operation of either cable-tool or rotary drills depends largely upon the ability, training and experience of the driller.

KEY ITEMS

In the rotary drilling method, the bit and the drilling fluid are the two key items. Both are indispensable in cutting and maintaining the drill hole. All of the components that make up the rotary drilling machine are designed to serve simultaneously these two functions —operation of the bit and continuous circulation of the drilling fluid.

The bit has to be rotated so that it will cut the hole through the earth materials to be penetrated. Enough weight or pressure has to be applied on the bit to make it cut effectively. The bit has to be moved up and down to ream portions of the hole; and it has to be hoisted out of the hole and changed. The bit has to be cooled (by the drilling fluid) because of the heat generated as it cuts and abrades its way through the formations.

The drilling fluid has to carry the cuttings away from the bit and out of the hole in a constant stream. The hydrostatic pressure of the drilling fluid is depended upon to keep the hole open and prevent its collapse when drilling through unconsolidated formations of clay, silt, sand, gravel, or shale. It has to puddle or plaster the inside of the hole with a coating of mud to prevent erosion of the wall.

Keeping in mind the essential interdependence of the functions of the bit and the drilling fluid will help in understanding the fundamentals of rotary drilling. A clear understanding of these fundamentals is not only necessary to properly operate the drill, but is a basic requirement in judging the results of rotary test drilling and in properly completing a water well once a hole has been sunk into a water-

Photo courtesy Reed Roller Bit Co.

Typical roller bit for rock drilling.

bearing formation by the rotary method. Choosing proper methods of installing well screens in rotary-drilled wells, for example, depends upon a knowledge of the drilling method.

THE BIT AND THE DRILL STEM

Two general types of bits are used — the roller type, usually called a rock bit, and the drag type of either the fishtail design or the three-way design. Drag bits have short blades each forged to a cutting edge and faced with hard-surfacing metal. Short nozzles direct jets of drilling fluid down the faces of the blades to clean and cool them. Drag bits cut rapidly in sands and clays but do not work well in coarse gravel or in rock formations.

The roller-type bits give a crushing and chipping action, making it possible to cut hard formations effectively. A jet of the drilling fluid is directed from the inside of the bit on top of each roller to flush the cutting surfaces. The cone-type bit has conically shaped rollers on spindles and bearings set at an angle to the axis of the bit. Another design has four rollers or cutters, two of which are set at an angle and two of which are on horizontal axles. All cutters have roller bearings.

The bit operates on the lower end of a hollow rotating shaft, called the drill stem. The drill stem usually consists of three parts: (1) one or more drill collars just above the bit, (2) one or more lengths of drill pipe, and (3) the kelly.

Each drill collar is, in reality, a very heavy-walled joint of drill pipe. One or more of them supply a concentration of weight just above the bit. This extra weight on the lower part of the drill stem helps to keep the hole straight. (The drill stem here is completely different from the cable-tool stem.)

The drill pipe is a seamless tubing, usually in joints about 20 feet long, with a tool-joint pin on one end and tool-joint box on the other. Sizes of drill pipe used for water well drilling range from 2⅜-inches to 4½-inches. The size indicates the outside diameter. In water well work it is important to use drill pipe as large as possible because water well drilling demands a relatively high rate of circulation of the drilling fluid. Drill pipe with large internal diameter keeps down friction loss in the pipe and reduces the power requirements of the pump.

API STANDARD DRILL PIPE

Outside Diameter	Inside Diameter	Inside Diameter, Full Upset
2⅜"	1.815"	1⅛"
2⅞"	2.151"	1-3/16"
3½"	2.764"	1⅞"
*4"	3.340"	2⅜"
4½"	3.826"	2-13/16"
5-9/16"	4.859"	3-13/16"
6⅝"	5.965"	5"

*Not an API standard size.

The kelly is the uppermost section of the drill stem. It passes through and engages in the opening in the rotary table. The outer shape of the kelly is usually square or hexagonal. One popular water well drill uses a round kelly with three lengthwise grooves or flutes cut into the outside of its wall. The kelly is made a few feet longer than one joint of drill pipe. Its inside bore is smaller than the inside diameter of the drill pipe because of the heavy wall thickness required. The severe working conditions to which it is subjected demand that it be made of a high-quality alloy steel.

The square, hexagonal or grooved section of the kelly works up and down through shaped drive bushings in the rotary table. With the bushings properly in place around it, the kelly—together with the rest of the drill stem and the bit—is forced to turn with the rotary table. While rotating, the kelly slips down through the drive bushings as the hole is drilled.

The upper length of drill pipe connects to the lower end of the kelly by means of a "sub" (substitute joint) which saves the threads on the kelly from wear. Obviously, the lower thread of this joint has to be screwed and unscrewed every time a length of drill pipe is added to the string. The upper end of the kelly connects to the water swivel with a left-hand threaded tool joint.

The whole drill stem hangs from the water swivel which, in turn, is suspended from the traveling block in the derrick. A heavy thrust bearing between the two parts of the swivel carries the entire weight of the drill stem while allowing it to rotate freely.

Note that the drill stem serves both the key items in rotary drilling—it operates the bit and it is an integral part of the mud circulating system.

DRILLING FLUID SYSTEM

The drilling fluid or drilling mud moves from the mud pump through the drill stem to the bit. Under considerable pressure, it streams out through the jetting nozzles of the bit at high velocity. It flows upward in the drilled hole through the annular space around the drill stem. At the ground surface, the mud-laden fluid, which is now also carrying the cuttings, is led away from the drilled hole through a suitable ditch to a settling pit. It overflows from the settling pit to a suction pit where it is picked up in the suction hose of the mud pump to repeat its course through the circulating system. Most of the cuttings

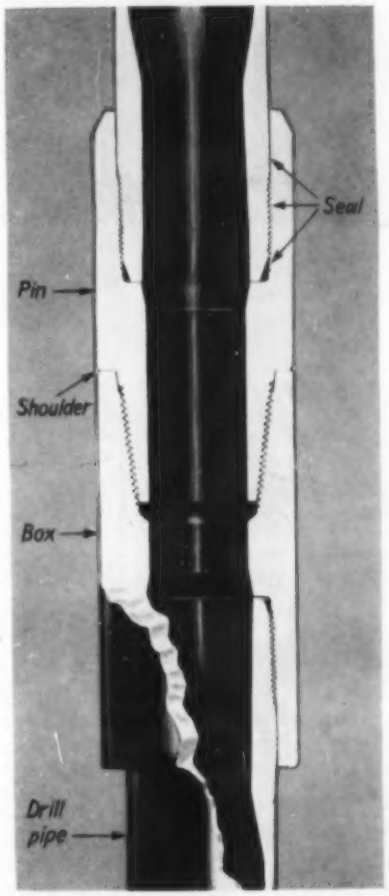
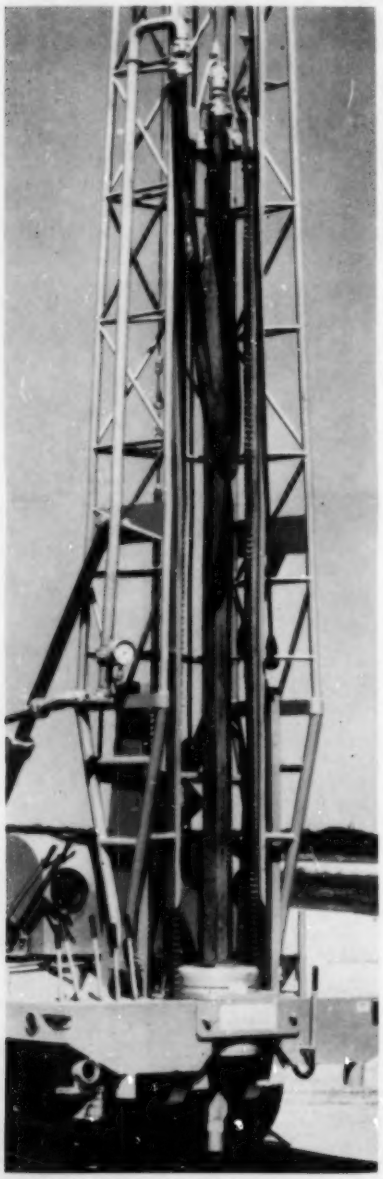


Photo courtesy Reed Roller Bit Co.

Section through drill pipe and tool-joint. Note thicker wall of pipe to strengthen it where the threads are cut for attachment of tool-joint. This is "internally upset" drill pipe.

are dropped out in the ditch and the settling pit.

In the conventional rotary method, the drilling fluid circulates in this manner. The fluid can be circulated in the opposite direction, however, and this is actually done in what is known as "reverse circulation" rotary drilling. The fundamentals of the reverse circulation system will be discussed in detail in another installment of this article.



The kelly shown here on one make of machine designed for water-well work is square. Note also the "standpipe," running up the left side of the derrick, and the mud hose between the standpipe and the swivel.

It is highly important to clearly understand the essential functions of the drilling fluid and properties it must have to do its job. The three primary jobs it must do are:

1. Support the wall of the drill hole.
2. Remove the cuttings from the bottom of the hole.
3. Cool and clean the cutting edges of the bit.

The character and quality of the drilling fluid may be built up and altered to fit varying conditions found in drilling different formations and in working at different depths. Let's analyze each of these functions and the properties that the drilling fluid must have to serve these purposes.

The drilling mud supports the drill hole and prevents caving by the fluid pressure it exerts outwardly against the wall of the hole. As long as this hydrostatic pressure of the fluid exceeds the earth pressure tending to collapse the hole, the hole will remain open. The pressure developed at any given depth equals the weight of the column of drilling fluid from the static water level up to the ground surface plus the excess weight of the fluid over the weight of water in the column below the static water level.

For example, suppose we are drilling with a mud weighing 70 pounds per cubic foot and the static water level in the formation being penetrated by the drill hole is 30 feet below the ground surface. The mud in the hole then develops a fluid pressure of 2100 lbs. per sq. ft. at a depth of 30 feet. Below this point, the mud pressure increases with each foot of depth by 70 minus 62.5 or 7.5 lb. per sq. ft. At 100 ft. below ground, therefore, the fluid pressure against the wall of the hole is 2100 plus 70 times 7.5 or 2625 lb. per sq. ft. Similarly, at the 200-foot level the outward pressure is 3150 lb. per sq. ft. Now, if the hole collapses under this condition, it means that the earth pressure is greater than these values. To provide the additional pressure required to hold the hole open, then, we must increase the weight of the drilling mud by thickening it.

Unfortunately, there is no reliable mathematical way to calculate the earth pressure tending to collapse a round drill hole in different

Photo courtesy George E. Failing Co.

The water swivel is essentially a heavy-duty, rotary, hydraulic connection. The mud hose connects in the goose-neck at the top and the kelly connects to and hangs from the rotating element in the bottom. The spindle above this particular swivel is used for suspending the entire assembly from the traveling block in the derrick.

kinds of earth materials and at various depths. The weight of mud required for a given situation, therefore, cannot be predicted at all closely. In practice, the driller relies on past experience in making up his drilling fluid. If he starts having trouble with caving while drilling, he must then add more clay or bentonite to the fluid to increase its weight and thus develop the pressure in the hole that will overcome the tendency to cave.

Thickening of the mud to increase its weight cannot be carried too far without causing trouble in pumping it. A point may be reached where the pump cannot properly force the heavy fluid through the system. In such a case, special materials have to be used in the drilling fluid to increase its weight

without increasing its viscosity too much. Ground barytes is used for this purpose. Chemical treatment of the fluid with certain phosphate can also be employed to accomplish the desired result.

HOW WALL CAKE FORMS

As drilling progresses, a mud cake or filter cake builds up on the wall of the hole. This rubbery lining of silt, clay, and colloids forms on the wall as the result of the pressure of the drilling fluid and the loss of some of the water from the fluid by filtration.

The wall cake does three things. First, it plasters up the wall and holds loose particles or crumbly materials in place so they will not fall off into the hole. Second, it helps protect the wall from being washed or eroded by the upward flow of the drilling fluid. Third, it wholly or partially seals the wall thus reducing the loss of fluid to the formations penetrated.

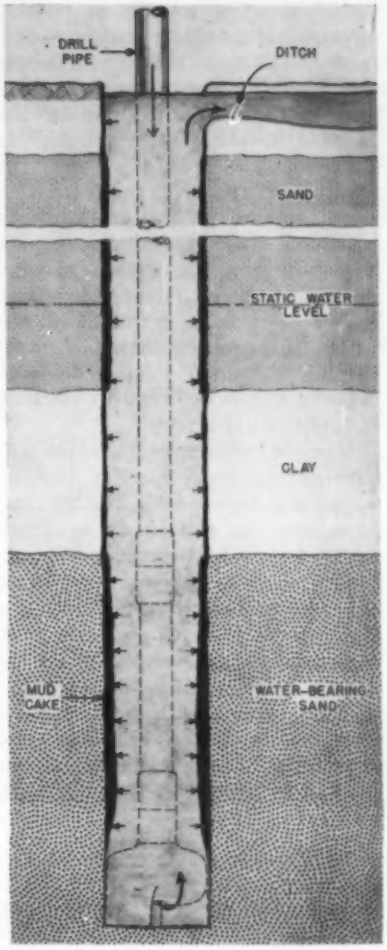
A popular idea about the function of the wall cake credits it with making the hole stand up—that is, preventing the outside earth pressure from causing collapse. This is a mistaken viewpoint. The wall cake has practically no structural strength. It can hold loose particles in place in the wall because it is sticky and plastic; but it cannot prevent even the slightest amount of outside pressure from collapsing the hole. Resistance to collapse depends entirely upon the hydrostatic pressure of the drilling fluid. The wall cake, then, should be thought of only as a flexible lining or membrane, something like a rubber balloon placed in the hole and filled with the mud fluid.

The properties of the drilling fluid and the porosity of the formations penetrated both influence the thickness of the mud cake and the amount of fluid that migrates outward into the formations. Correct values of the required properties—such as viscosity, density, gel strength and the like — have not been developed for water-well drilling. In fact, drillers have not given the matter too much thought. They have tagged along with some of the practices used with muds for oil-well drilling without stopping to think about the differences in drilling fluid requirements in the two fields.

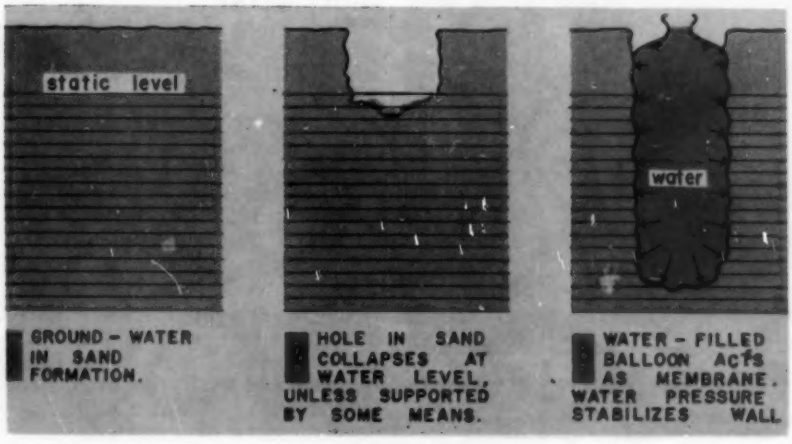
In oil-well drilling, low "water loss" is an important property of the fluid. A mud with low water loss will permit very little or no water to separate from it and seep through the wall cake. Such loss of water into many types of oil bearing formations adversely affects their yielding ability. In contrast, water loss as a drilling fluid property for water-well work is of little consequence, in itself. What is of much concern in water-well drilling is the extent of movement of the whole mud-laden fluid into the pores of the water-bearing sand.

Good water-bearing sands are much more pervious than the best oil-bearing sands so that an appreciable quantity of mud flows out and invades the water-bearing formation. Mud invasion continues until the pores of the formation are clogged. Once effective clogging takes place, the wall cake forms in the hole. In coarse sand and gravel hundreds of gallons of the fluid will be lost to the formation before the wall cake can be formed. The big disadvantage of this situation is that all the mud that is lost to the formation must be removed later from the pores of the water-producing strata during development of the well. Otherwise, the sand will remain partially clogged and a poor well will result.

From this point of view, the drilling fluid evidently needs to be able to fill and seal the pores of sand and gravel formations with a minimum of invasion. Very thick mud may accomplish this but the pump may not be able to handle it, so a compromise must be made in choosing the most practical viscos-



This diagram shows how the hydrostatic pressure of the drilling fluid pushes against the wall of the hole to prevent its collapse. The mud cake acts as a membrane or lining to retain the drilling fluid, or at least to prevent excessive loss of fluid through the pores of sand and gravel formations. The wall cake is thicker where the hole penetrates sand and gravel formations. Some of the fluid flows out into these porous materials. Some water is squeezed out of the fluid leaving solids deposited as the wall cake. This action continues to build up the thickness of the mud cake until the wall of the hole is completely sealed.


static level
water
GROUND – WATER IN SAND FORMATION.
HOLE IN SAND COLLAPSES AT WATER LEVEL, UNLESS SUPPORTED BY SOME MEANS.
WATER – FILLED BALLOON ACTS AS MEMBRANE. WATER PRESSURE STABILIZES WALL.

ity. Use of a certain proportion of Aquagel or other bentonite clay in the drilling fluid helps it to seal the formation pores more effectively because bentonite causes the fluid to develop "gel strength" as its velocity decreases. Since the mud moves slowly in the formation pores, it can develop gel strength within a short radial distance to help minimize the extent of mud invasion. The advantage thus gained, however, is partially offset by the greater difficulty in removing the mud during development of the well, precisely because of its high gel strength.

Much remains to be learned about the correct properties of drilling muds for water-well drilling and how best to obtain these properties. Laboratory experiments can supply some of the answers. However, if more drillers would use simple field tests to measure even one or two properties, such as weight and viscosity, and compare the test results with drilling experience on a number of jobs, they would build up much valuable information on this important subject.

(To be continued in next issue)

Legal Status of Ground Water

Interest in legal control of groundwater use and well drilling increases constantly. Many states are adopting new laws or new regulations. All drillers need to be informed on what is taking place in this important area.

COLORADO

A new law regulating groundwater use and well drilling was passed by the 1952 Colorado General Assembly and approved by the Governor on April 17, 1953. This new law repeals all previous ground-water legislation.

The purpose of the act is to protect and conserve ground-water resources by regulating well drilling, by requiring beneficial use of ground-water and by prohibiting waste.

Administration of the groundwater act is to be carried out by the Colorado Water Conservation Board, acting through its director, Mr. Ivan C. Crawford. The board will establish ground-water districts as soon as the necessary engineering studies are made to determine boundaries. The board will develop rules and regulations regarding casing to be used in wells, the sealing off of test holes and old wells, compilation of well logs and well histories which are to be placed on public file, and the operation and use of wells to prevent waste and pollution of underground waters.

The regulations for well installation, well operation and water use will apply only to wells within ground-water districts, and then only to wells producing more than 3 gpm. Thus, this part of the law has no practical effect until districts have been set up.

The new law sets up licensing and bonding procedures for well drillers. This part of the act becomes effective immediately. It provides for payment of a driller's license fee of $25.00 per year; and before a license is issued, each well driller must post a bond in the amount of $5,000 to insure that he will comply with the provisions of the law and the rules and regulations that will be set up as time goes along.

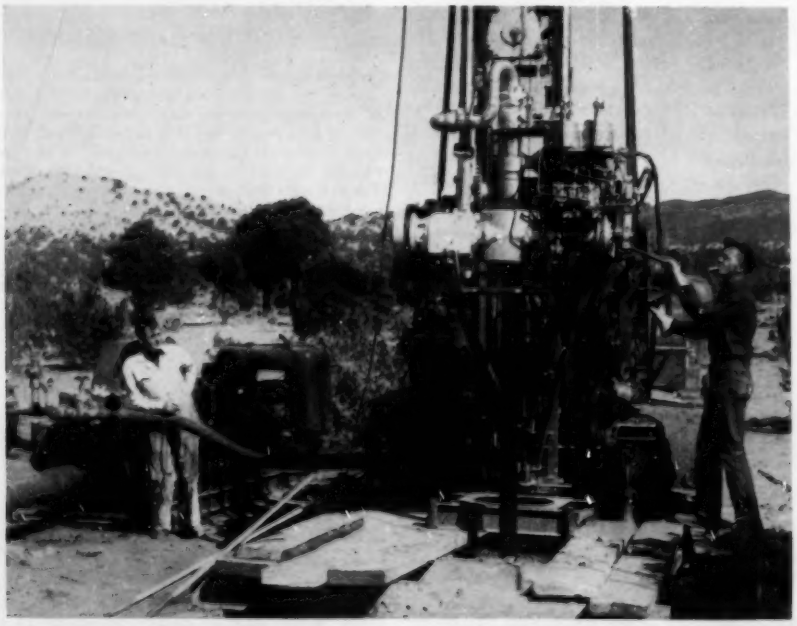
NEW MEXICO

The ground-water laws of New Mexico regulate well drilling and the use of its water resources. However, wells can be drilled without limit just over the state line in Texas, since Texas has no effective law to control ground-water use. New Mexico claims the Texas wells are draining much water from the water-bearing formations in New Mexico and that something ought to be done about it. There have been suggestions from some that New Mexico ought to start legal action unless Texas remedies the situation. This argument points up only one of the many complications in ground-water control.

RHODE ISLAND

The State Legislature appropriated $25,000 for a survey of Rhode Island's groundwater resources. The survey will be made by an agency known as the Rhode Island Development Council. Some preliminary studies of the situation of the situation have been made by this agency, with the U. S. Geological Survey cooperating.

The action taken by the legislature follows up the recommendations of one of its committees. More than two years ago, this committee pointed out that Rhode Island could easily be facing serious shortage of water unless new developments are started.



A Stardrill combination cable-tool and rotary drill belonging to R. Ven Turner of Albuquerque, New Mexico. Working northwest of Santa Fe at an elevation of 8,000 feet, the machine is drilling a 16-inch irrigation well in coarse sand and gravel. On this job a 10-inch hole is drilled first and then reamed to about 21-inch diameter after which 16-inch casing is run in the well.

PRICE CUTTING VERSUS PROFITS

By Norm Ovrom*

Every drilling contractor has had to turn down business during the past few years because of shortages of material or lack of enough men and equipment. Most drillers haven't had to worry much about their own selling methods for keeping up a good volume of business.

This picture is beginning to change, however, and those who fail to brush up on effective methods of selling or fail to put some life into their selling program are likely to wind up with time on their hands but not enough jobs.

The tendency to cut prices when the volume drops off a little is a practice almost as old as drilling itself. But to simply rely on a lower price for getting the job is poor salesmanship. Besides, it gets you nowhere because when another driller meets your lower price you are right back where you started. In fact you are worse off—you are both working for less money.

I believe it is safe to say that the weakest point in most well drilling organizations is their merchandising and salesmanship. Those of us who are accountants and get a chance to see what makes these businesses "tick" are doubly convinced of this. We also feel that the next most common fault is a lack of cost information. By that I mean the inability to estimate accurately the value and cost of various phases of each business. This knowledge is the first requisite for the successful control of any business.

These two things — salesmanship and cost accounting — are really more closely connected than most persons think. For the purposes of this article, however, we will stay pretty much away from the cost accounting angle because it is a subject that should be given special consideration by itself.

Most well drillers do a good job of well drilling. They know their business. But quite the contrary is true when it comes to salesmanship. Too many take it for granted, some ignore it, and others just "fumble the ball."

Now I do not want to be misunderstood here. I simply wish to offer some constructive criticism — to point out what appears to be a fact in too many cases. Recognition of a bad situation is always the first step toward correction. I want to assure you that with some study and effort, a good well driller can do a real job of selling himself and his merchandise, not only in competition with other drillers but also in competition with other merchants who are after the customer's money. It is often necessary to

Good salesmanship can change failure into success.

sell customers on the value of a good water supply because many times there is a question in their minds as to whether they should buy a new machine or a new well, a new refrigerator or a new pump, a new tractor or a better water system on the farm.

Most drillers have one big factor in their favor when it comes to selling their product and merchandise — they really know the facts about them. So the problem is chiefly how to put their story across. I'd like to list a few "rules" that I hope will be helpful in solving this problem.

First of all, look the part of a good salesman. Dress neatly and conservatively. Boots and work clothes are fine on the job. You wouldn't, however, wear them instead of a business suit when you call on a customer any more than a doctor would wear a face mask and blood-stained operating gown when talking with a patient in his office.

Next, don't figure you can do a job of selling by arguing. A good salesman brings a customer around to his point of view by starting with the things they both agree upon and presenting the differences without making an issue of them. Remember, most customers want the facts, but nobody likes to lose an argument. The salesman who talks the loudest, or the longest, rarely gets the business.

Don't knock the other man. People just don't like a knocker. Sell your stuff on its own merits. It should be obvious that the time you spend running down the other fellow is just that much lost time for you — time you could have used effectively and positively in building up your own case. As a matter of cold fact, knocking the competition may actually result in turning the customer to your competitor. This has been demonstrated many times in politics and it is no less true in business. Remember, too, that a poorly skilled competitor actually sends future prospects your way by every bad job that he does.

Right here let me emphasize the most important point of all — be sure your jobs are finished in a clean-cut fashion. Don't let tag-ends go unfinished. Don't let adjustments drag out a long time. Don't let the final settlement be delayed a day longer than necessary. To do any of these will ruin your sales efforts. Nothing I can think of does more harm to a well driller's sales than to get the reputation of not bringing his jobs to a clean-cut, satisfactory completion. Delays are irritating and they invite additional complaints. Experience has shown over and over again that when a job isn't completed, collection problems are the immediate result. My advice to you is to complete each job 100 per cent before you leave it. When you do, you'll have a satisfied customer and win a friend and booster. Don't forget

You're in trouble when expenses on a job run heavier than the price you bid.

(Continued on Page 10)

*Mr. Ovrom is an accountant and executive secretary of the Minnesota Water Well Contractors Association.

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TOM'S COLUMN

Dear Fellows:

I was goin' through some ol' records in the office the other day an' I came across th' file on a job we did some years ago. It was 'way out of our territory, an' we did it for a mighty good well driller friend of ours who had done practically all rock work an' felt he wanted somebody with him on this job who had done a lot more sand and gravel well work than he had. We used his rig an' part of his tools, an' shipped in some of our own. It was one of them jobs that was pretty much of a disappointment in the end; but it was kind of out of the ordinary an' had some interesting angles to it. I figgered it might be worth telling about.

Th' whole thing started when th' local manager of a chain store, who was a friend of this driller, got in touch with him 'bout putting in a well fer air conditioning in his store. The engineer who had charge of all such work fer th' chain of stores was with him. There were several other big stores in th' downtown district that had air conditioning, but they all had mechanical refrigeration an' were using their deep wells to furnish water fer th' condensers along with their other needs. Th' water from these wells was too warm to use fer a straight well-water job.

Now, this engineer was anxious to do th' whole job with well water if possible because, of course, it would cost a lot less to operate an' would probably mean less investment, too. Th' three of them had a long session going over th' possibilities of getting a supply o' well water that was cold enough. Th' geological records of wells showed a shallow sand formation that seemed to stretch pretty well over th' whole downtown area and right out into th' country beyond th' city. But there wasn't any records of any wells finished in it. This driller knew there had been lots of drive point wells in it before th' city mains was put out to th' out-

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skirts, an' he had put down half a dozen small farm wells in it where he found some good gravel. But fer th' most part he an' the other drillers had passed it up an' gone into th' rock which was a lot deeper but was a pretty good supply. He told me that in most places this sand was either pretty fine stuff or had a good bit of clay mixed in. Being a "dyed-in-th'-wool" rock driller in them days, he didn't believe in doing anything with a sand formation unless it was real coarse stuff that gave a lot o' water with th' bailer, open bottom.

Anyway, they couldn't find out anything about th' water in this sand formation in th' city itself, but they did get pumped samples from some wells out beyond th' city limits. Th' water checked out O.K. an' th' engineer was specially happy when he found th' temperature was between 55 and 57 degrees. Th' rock wells he checked were up in th' 60's some place. He had set 60 degrees as th' top limit fer a straight water cooling installation. So this part seemed to be in th' bag.

Th' next question was, how much water they could get from this formation. That's where I got into th' picture. With th' new methods they've worked out in later years, I reckon we could of come through with a better answer than we could then. About all we did was try to get as good an idea as we could about th' material an' do some checking on th' yield an' drawdown in one of the farm wells — all of which didn't give us much to go on but looked all right as far as it went.

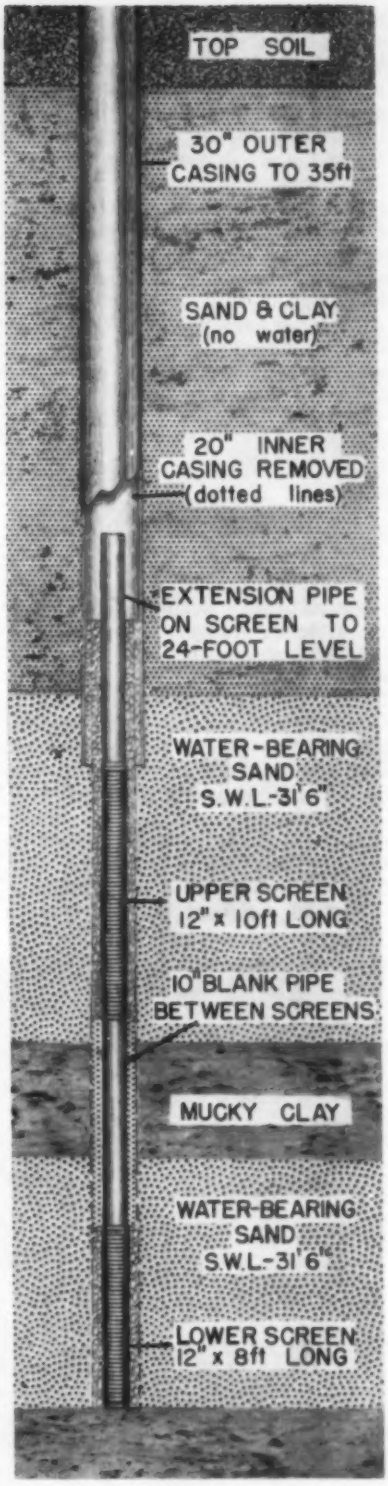
Skipping over a lot of details, I'll jest say that we agreed on th' kind of well we'd put in an' made a deal. There wasn't much advantage in doing any test drilling because there was jest one place — about 10′ x 10′ — that th' well could go without a lot o' trouble an' expense. We knew it wouldn't be more than 75 feet deep from logs we had of rock wells within a few blocks in all directions from this location. And by this time th' engineer was hollering fer action. He was anxious to find what we could get so he could make his final plans an' get th' installation into service by th' time hot weather hit.

So we set right out with a 30-inch casing which we sank down to 35 foot. Th' first few feet were in fill — a mixture of everything from cinders to busted glass — then dry sand with streaks an' globs o' clay all through it, which went down to 32 foot. Here we hit clean sand with water. It was fairly fine stuff. We stopped our 30-inch at 35 foot an' ran down with 20 inch O.D. standard pipe. This vein of sand was 14 foot thick. Then we ran into a 4-foot layer o' mucky clay — soft an' slimy. Under this was 11 foot o' sand jest about like th' first sand at th' top an' grading down to a little coarser toward th' bottom. The water level in both veins was th' same. We reckoned it was all one formation an' th' clay was jest a streak that happened to lay in it right at this location.

We put in a screen line that we centered in th' 20-inch. It was made up of a 12-inch screen 8-foot long, No. 60 slot at th' bottom, then a piece of 10-inch blank pipe, then 10-foot o' 12-inch, 60-slot screen, then a 10-inch extension pipe at th' top that reached up to th' 24-foot level. We filled in with a filter gravel we got that had 90 percent coarser than .050″ an' 50 percent finer than .080″. We pulled back th' 20-inch by a half-length an' bailed th' well until it was purty clear. We ran as big a bailer as we could an' worked it up an' down a good bit an' pulled it out fast. That was all th' developin' we did. Th' water seemed to come in good.

We put in some more gravel to make up fer th' settlement we got, an' then pulled out all of th' 20-inch. We worked our bailer again an' then put in th' test pump which was belt driven. We was real disappointed with our yield. We only got 125 gpm with 13 foot o' drawdown at th' end of 10 hours pumpin'. This was under 10 gpm per foot o'drawdown. We backwashed with th' pump a while an' then changed over to pump more water to see what it would do. That's where we got surprise No. 1. Th' doggone well gave 250 gpm with 19 foot o' drawdown. I never have been able to figure that out. I can't believe th' backwashin' we did changed it anywhere near that much. I still think it was a case where th' yield per foot o' drawdown went up instead of down under heavier pumping. It's a puzzle to me.

That settled things fine for quantity of water because it gave


TOP SOIL
30" OUTER CASING TO 35ft
SAND & CLAY (no water)
20" INNER CASING REMOVED (dotted lines)
EXTENSION PIPE ON SCREEN TO 24-FOOT LEVEL
WATER-BEARING SAND S.W.L.-31' 6"
UPPER SCREEN 12" x 10ft LONG
10" BLANK PIPE BETWEEN SCREENS
MUCKY CLAY
WATER-BEARING SAND S.W.L.-31' 6"
LOWER SCREEN 12" x 8ft LONG

This diagram shows the details of the well described by Tom. A 10-foot well screen was set in the upper sand and an 8-foot section in the lower one. Note that the top of the lower screen was kept a few feet below the soft clay layer.

us all we needed and plenty to spare. But then we got our teeth kicked out. Th' durned water showed 67 degrees temperature — and it didn't lower at the end o' 24 hours pumping. That's another thing I ain't figgered out fer sure. This well was not far from th' river, right in th' heart of th' downtown district. Maybe all th' warm basements, boiler plants, sewers, water mains, and th' like had raised th' temperature over such a big area it couldn't be offset by pumping one measly well. Or maybe this wasn't really connected with th' shallow vein that we checked outside th' city limits. Fer my part I think th' first explanation is th' right one. What do you think?

Th' well was a disappointment, because they couldn't use it for a straight well-water cooling job; but it wasn't a total loss because they did use it instead of city water as condenser water.

It was a good well as far as th' way it gave water, and one thing I want to point out here is that on this kind of a well there are several things that ought to be done th' way it was done on this job — at least to my way of thinking.

First, screen both veins. Don't expect th' gravel pack to feed down from th' top vein to th' bottom one. You're likely to be disappointed.

Second, th' best way to treat a well like this with gravel is to set your pack between th' screen and a temporary casing that you pull back out. It gives you a much better chance to get a pack that is even all around.

I haven't figured out all th' answers to this job yet.

Third, when you've got bad stuff like that soft clay to deal with, give enough space between it an' th' end of th' screen — especially above th' bottom screen.

Fourth, don't try to use a big, coarse gravel envelope. It don't help th' yield and if it's too coarse, all hell won't stop th' sand comin' through no matter how big you make th' diameter of th' pack. Fit th' pack to th' sand an' th' screen to th' pack. It's the only safe way.

Yer ol' friend,

TOM.

Pump-testing a 12-inch well, 212 feet deep in fine sand, drilled by Mastrian Bros. of Superior, Wisconsin, for the Twin Ports Dairy Co-op. A Johnson Everdur Well Screen, 45 feet long, with No. 10 slot openings was installed by the bail-down method. The well is delivering 700 gpm with 30 feet drawdown. Maximum yield of this well would be in excess of 1500 gpm.

PRICE CUTTING

(Continued from Page 7)

— when you complete a job you get paid!

All of these "rules" about salesmanship are pretty much common sense, and the important thing is to give them some real thought and then put them into practice. Generally speaking, a well driller is as much a buyer as he is a salesman, so if he sells the way he likes to be sold, he won't go far wrong.

Now comes a real sore spot and a tough nut to crack in lots of cases. It's our old enemy, "Price Cutting." It's a curse in many businesses and a bad one in the well drilling business. Let's be clear on one point at the outset — price cutting is not just selling at a lower price than somebody else, if that price is justified by lower costs. Such lower prices are the proper results of competition and efficiency. The price cutting we're talking about is a reduction in price which is **not** based on lower costs. It is usually just a substitute for salesmanship. The fact is that most people who use it don't know what their costs are and they just cut prices instead of doing a job of selling.

What does price cutting do? Actually it results in a direct reduction in gross profit. Let's say, for example, that the cost of a job is $3.00 a foot including $1.00 per foot of **gross** profit. Then if the price is cut to $2.75 a foot, that's only about an eight per cent cut in the cost to the buyer but it's a 25 per cent cut in the driller's gross profit.

Now, let's take a look at what happens to gross profit. Assuming that this driller does a $45,000 business in a year and his gross profit is as shown above, he should make $15,000 gross profit. Out of this he pays all of his costs beyond the direct costs that go into making a well. These include sales costs (for the driller himself or somebody else), bookkeeping, office, advertising, taxes and a whole list of such things. Say that these amounted to $10,000. This would leave the driller $5,000 as his income for the year.

If he reduces his gross profit by price cutting, as we mentioned above, his gross profit would be reduced 25 per cent — from $15,000 to about $11,250. Unless he can

find a way to reduce his other costs, this leaves him with only $1,250 as his income — a reduction of 75 per cent. And so this vicious cycle goes—eight per cent to the buyer, 25 per cent less gross profit and 75 per cent less net income. The figures here may not be correct, but the general result is the same—a small saving for the buyer ends up as a big kick in the pocketbook for the price cutter.

Don't forget another thing, either. The most contagious "disease" in business is price-cutting and it's one of the hardest to cure once it gets started. It takes brains to run a business properly; but anybody can cut a price. Ironically, it's usually the man who can least afford the results of price-cutting who starts it! Nine times out of ten he cuts prices because he does not know his costs and does not realize, therefore, what the end result is likely to be. That's where cost records come in. Every driller should make a sincere effort to have his books set up so they will give him dependable information on his costs. A driller with this information may find he can, in specific cases, lower his price to real advantage. On the other hand, the man who just cuts prices as a substitute for salesmanship without **knowing** his costs or the predictable results of a price reduction is only firing a shot in the dark — a shot that might be suicidal.

Price cutting can empty your piggy-bank.

Keep this in mind at all times: price may be an important factor in selling, but it is never a substitute for salesmanship.

——o——

API specifications for tool joints have been adopted as standards in the Union of South Africa and in Australia. The National Standard Laboratory of Australia now has a set of master gages for cable tool joints which are used to check the reference gages of various drilling tool manufacturers in that country.

SCREENINGS

A negro spinster of uncertain years decided at long last to join the Baptist Church. As the deacons plunged her into the river the first time she gasped, "I believe." The second time she chattered, "I believe." A third time, gulping for air, she sputtered, "I believe." One of the elders interposed, "You believe what, sister?" She eyed him savagely, "I believe you stinkers are trying to drown me."

——o——

Company Officer: "You are charged with using insulting language to your sergeant."

Private: "Sir, I was only answering a question."

"What question?"

"He said, 'What do you take me for?' and I told him."

——o——

A mild little man walked into an income-tax inspector's office, sat down and beamed on everyone.

"What can we do for you?" asked the inspector.

"Nothing, thank you," replied the little man, "I just wanted to meet the people I'm working for."

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Thought for the day: It won't do any good to spank a girl after she's sixteen, but it sure is a lot of fun.

Seabrook Farms processing plant, the world's largest and most modern quick-freezing plant, is situated in the midst of their extensive farm lands. Crop production is insured by using a number of wells equipped with Johnson Well Screens. Seabrook Farms processes frozen food sold under several nationally-known brands. This unique installation is near Bridgeton, New Jersey.

Association News

This section is devoted to the exclusive use of water well drillers' associations, both state and local. Notices, announcements, changes of officers and other items should be sent to The Editor, Johnson National Drillers' Journal, 2304 Long Ave., St. Paul 14, Minnesota.

IDAHO

As already announced, the Idaho Drillers' Association will hold its convention at Shore Lodge, McCall, on June 28 and 29. This promises to be an excellent meeting. All Idaho drillers should attend. G. Paul Smith of Jerome is in charge of exhibits. W. B. Bowler, secretary, is arranging other details.

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PENNSYLVANIA

Leon Slauch of Lincoln University has taken office as the new president of the Eastern Section. Tom Keyes of Malvern was elected secretary for 1954-55. The annual convention held in Lewistown in April elected Joseph Heidelmeier of Washington as executive president and Edward D. Potter of North Wales as executive vice-president. Annual dues were voted to be continued at $25 for this year.

The Eastern Section will hold its third annual picnic at Downey Park, Allentown, on Saturday, June 26. This big event is for members and employees, their families and friends.

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OHIO

The regular meeting of the Ohio Well Drillers Association was recently held at the Hotel Fort Hayes in Columbus. A report of the national convention was given by A. J. Asher and Bob Knodle.

Regulations and laws regarding well drilling in the state were discussed. Association members are actively working with a committee of the state legislature to formulate laws which will benefit the good drillers of the state and will control the water situation.

To assist the Ohio group in developing ideas for strengthening their organization, Howard Cribley of Dexter, Michigan, explained the workings of the Michigan Association. He also commented on the new insurance program that the Michigan Association has undertaken.

G. D. Applegate of Newark is now president of the Ohio Association and R. H. Stein of Pemberville was elected secretary. Stein succeeds E. D. Allen, who has resigned after 15 years of faithful service.

Another meeting was scheduled for June 12. Members are advised to contact Secretary Stein for further details.

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WASHINGTON

An extremely interesting and informative meeting of the well drillers of southwest Washington was recently held in Vancouver. Members of the Oregon Association were guests.

To aid the members in merchandising water softeners, two different types of water hardness testing kits were demonstrated. Legal problems of the driller were discussed by an attorney who had some good advice for all of us: "that it is much less expensive to keep you out of trouble than to get you out."

The members have instituted a plan for the co-operative advertising of their services. A master plaque of the association emblem, stressing professional workmanship, will be made up by the Association. Mats, suitable for printing in the local newspaper, will be made from this. The individual mats will carry the names of all members in a locality.

The summer meeting of the Association will be held July 17 in Seattle.

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MISSOURI

The annual meeting of the Missouri Water Well Drillers Association was held in Jefferson. At this fine meeting, 73 members, 45 associate members, 5 honorary members and 21 guests were present.

One of the more interesting sessions at the convention was a discussion of the requirements concerning health policies in the construction of water wells for tourist courts, cafes and schools. The panel was led by L. E. Ordelheide, Director of Public Health Engineering for the state.

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KANSAS

The Kansas Water Well Drillers Association held the spring meeting on April 3 in Dodge City.

The main topic was a roundtable discussion of proposed legislation affecting well drillers. The date for the annual meeting to be held later this year has not been decided upon.

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NOVA SCOTIA

Sydney Trask of Cambridge was elected president of the newly-organized Nova Scotia Well Drillers' Association. Leading drillers of the Province felt a need for an organized group to help improve standards of well drilling and to cooperate with governmental agencies. The constitution of the Ontario association, amended as required, was used as a pattern for the Nova Scotia association.

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NEW BRUNSWICK

Drillers in this Canadian province met recently and organized the New Brunswick Water Well Drillers' Association. Mr. Arthur LeBlanc of St. Anselme was elected president.

The aim of this group is to improve the standard of well construction, support water conservation measures and cooperate generally with appropriate agencies of the provincial government.

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TEXAS

The Texas Water Well Drilling Contractors Association will hold its annual meeting at the San Jacinto Battlegrounds southeast of Houston. New officers will be elected at these meetings on July 31 and August 1.

Proposed legislation by the State to license and bond all drillers will be discussed.

Genuine Texas hospitality will be shown to members and their guests. Seven hundred pounds of beef will be barbecued on the spot and noon and evening meals will be served under the big tent. On Sunday, boats have been reserved for a day of deep sea fishing on the red snapper banks off Freeport, Texas.

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VIRGINIA

Another fine meeting of the Virginia Water Well Drillers Association took place at Winchester on May 7 and 8. Several social events organized by the committee in charge were thoroughly enjoyable.

Garland Sydnor reported on some unusual work being done on improved methods of checking samples of water from wells for

A record crowd attended the 1954 annual meeting of the Nebraska Well Drillers' Association. W. H. Kroeger of Litchfield having attended for 20 years and Emil C. Bruns of Schuyler having attended for 15 years were honored for these records. Dr. G. E. Condra was given a special award for his devoted efforts in organizing the association and guiding it through 25 successful years.

bacteriological contamination. E. C. Meredith of the State Board of Health gave an interesting talk on requirements for public water supplies. He explained new laws, to become effective July 1, that permit counties to set up regulations for public water supplies.

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WISCONSIN

The 26th annual convention of the Wisconsin Well Drillers' Association was held April 1, 2 and 3. Meetings were held at the Hotel Northland in Green Bay.

The members were advised that important changes have been made by the state legislature in the laws on well construction. The law now makes it mandatory for the State Board of Health to allow the use of well pits in certain instances. Minimum reasonable standards for the construction of well pits are to be set up by this Board.

Under another new provision of the law, every pump installer must be licensed and registered with the State Board of Health. All new applicants for registration as well drillers must have at least two years experience with a registered driller.

A state-wide educational program, addressed primarily to the farmer, will be developed to familiarize the dairyman with the laws regarding the construction of well pits to be used for the production of milk for human consumption.

A slate of new officers was elected for the year. They are: Martin Mastrian of Superior, president; Emil Goecks of Milwaukee, first vice-president; Malcolm Veitch of Seymour, second vice-president; and Glenn Garber of Milwaukee, treasurer. Ralph H. Nienow of Merrill was re-elected secretary-counsel.

Harvey Kriegel of Tigerton, Virgil Thomas of Peshtigo, and Emil Goecks were elected to two-year terms as directors.

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MICHIGAN

A record number of well drillers attended the 26th annual convention of the Michigan Well Drillers' Association. This is undoubtedly the finest convention in the country, and attracted a registered attendance of 277 persons plus others who did not register. Complete water supply systems, welding equipment, gas engines, turbine pumps, well screens, tools and the most modern drilling equipment were on display for the members in 45 attractive exhibits. Six drilling machines were set up outside. Outstanding persons associated with the well drilling business spoke on a variety of subjects and demonstrated useful techniques and equipment.

At the business meeting, Karl Geiger, Jr., of Belding, was elected president and Owen Corsaut, Jr., of Birmingham, was re-elected secretary-treasurer. The first vice-president is now Theron Brewer of Parma, and Jim Price of Oxford is second vice-president.

The first evening about 150 attended the free "get-acquainted party" at the Hotel Olds. Some 300 people attended the banquet held on Friday evening in the Masonic Temple.

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ONTARIO

The past year has been very encouraging for the Ontario Water Well Association. The membership has risen in one year from 84 to a current number of 144. This includes both active and associate members. Some 200 drillers, employees, exhibitors and guests attended the convention held at Oakville, May 13 and 14.

Frank Hammond of Huntsville was elected president; S. S. Rice of Streetsville is vice-president; and the secretary-treasurer is C. Douglas McLean of Ottawa.

The Board of Directors, from the various divisions of the Province, are as follows: R. H. Casselman of Williamsburg, W. D. Davey, Sr. of Verona, J. B. Longstreet of Matheson, Frank Harrison of Thornhill, Neil Hopper of Seaforth, Don Jacobson of Port Credit, Elmo Hoover of Aylmer and Carl Laramie of Kingsville.

The Association is encouraging the drillers in each of eight areas of the Province to set up district groups. Each such group will eventually elect a director to the board of the Association. Local groups make possible more effective exchanges of ideas among members.

The success of this meeting has led the directors to decide upon a similar convention in 1955 at the same location.

Advertisements

We will insert advertisements for drilling equipment wanted or for sale, help or work wanted, etc., for our readers, free of charge. Advertisements must be brief, and we cannot assume responsibility for them, but will be glad to put parties in touch with each other by this means and suggest that they investigate any offers or inquiries carefully for themselves.

WANTED TO BUY: Late model, medium-size, water-well drilling machine in A-1 condition. Prefer #40 or #42 Sanderson-Cyclone, with or without truck. Ralph Scott, R.R. 3, Pendleton, Indiana, Phone 294R.

FOR SALE: Bucyrus-Erie 24L, 1948, excellent condition with or without tools and lines; semi-mounted, 40-foot mast, power hoist, catheads, casing reels. Price bare machine $5,900. Complete with lines and tools $6,750. Max Toliver, Orleans, Indiana.

FOR SALE: Speed Star 240, two years old equipped with LeRoi engine, 30-foot derrick, cathead and double string of tools for 4" holes, 300 ft. of ⅝" drill cable and 500 ft. of ⅜" sand line; with or without 1950 Dodge truck. Duane C. Olson, R.R. 2, Box 93-A, Devils Lake, North Dakota.

FOR SALE: Model B Cyclone, wood frame, mounted on 1934 model 2½-ton Dodge truck; machine and truck in good condition considering age. Both for $475. Harold Inman, R.D. 2, Jefferson, Ohio.

FOR SALE: Well drilling and pump business. Established concern. Selling because of husband's death. Write for equipment and tool lists and other details. Elizabeth Freeman, P. O. Box 2927, Orlando, Florida.

FOR SALE: Bucyrus-Erie 24L drilling machine, mounted on ten-wheel army truck. Good condition. Write: Libby & Freeman, P. O. Box 2927, Orlando, Florida.

FOR SALE: One jar bumper, long style, 4½" diameter with 3¼" fishing head. Price, $50, f.o.b. Reading. E. C. Lenhart, 2606 Philmay Terrace, Mt. Penn, Reading, Pennsylvania.

FOR SALE: Well drilling business. Will sell tools separately. Complete list furnished on request. Includes 6 H.P. kerosene engine, 300-lb. and 100-lb. drive blocks, 4" pump to mount on well machine. Priced at 50% of cost. L. Matteson, Tustin, Michigan.

FOR SALE: American Well Works turbine pump. A 10-inch, 14 stage, all-bronze pump, 200 gpm, 550' TDH; with 350' of 5" column pipe; water lubricated; new 50 H.P., 220-volt, 3-phase motor. Price $3,300 f.o.b. Liberty. Sullivan County Plumbing and Heating Supply Company, Inc., P. O. Box 549, Liberty, New York.

FOR SALE: Cyclone drilling machine, 1951 model, all steel; 5" jetting pump and clutch; Wisconsin VF4 engine with clutch; mounted on 1948 model 2-ton Ford truck. May be purchased with or without truck. Rodney Wieber, Box 211, Lidgerwood, North Dakota.

FOR SALE: One pair 4" x 6" Howell jetting pumps, complete with chains, sprockets, shafts, for mounting on drilling machine. All parts in A-1 shape. Price, $175. Erwin M. Johnson, Hawley, Minnesota.

FOR SALE: Well drilling and pump business established 50 years in good community, close to Albert Lea. Block building 25 x 50, lean-to 11 x 34, garage and warehouse 25 x 25, office and living quarters in block building. Selling business because of ill health. Hellie Real Estate, 203 South Washington, Albert Lea, Minnesota.

FOR SALE: New all-steel, hollow-rod, drilling machine, 28-foot mast; for 2", 3", and 4" work. Almost new, all-steel, cable-tool drill with 36-foot telescope mast; mounted on three-wheel trailer; for 3", 4", and 6" work. Ed Pluter, Route No. 1, Manistee, Michigan. Phone: 1345.

WANTED: Well driller to operate Model 50 Keystone or 22-W Bucyrus-Erie machine. Must know bit dressing. Plenty of jobs with good pay. Opportunity for experienced, sober man. Write: Twin State Well Company, Box 62, Bethel, Vermont.

WANTED TO BUY: Armstrong Model 45 drill without tools, if priced right. John Hamilton, Ellsworth, Wisconsin.

WANTED TO BUY: Small rotary machine fully equipped for water wells and having reverse circulation. Prefer truck mounting. Max Toliver, Orleans, Indiana.

FOR SALE: No. 50 Keystone drilling machine, 1948 model, with 38-foot derrick, stiff braces, casing reel, blower, tool guide, 45 H.P. Continental engine one year old; 600' of ¾" drill line, 600' of ⅜" sand line, and 250' of ½" casing line. Power derrick raiser; oil shock absorber in derrick head. Machine in fine condition. Twin State Well Company, Box 62, Bethel, Vermont.

Quentin Richey of Stone Fort and his Keystone drill working in southern Illinois.

FOR SALE: Established well drilling business. Completely equipped. In prosperous eastern Nebraska. Mrs. H. B. Bruner, 1349 North Platte, Fremont, Nebraska.

WANTED: Used Bucyrus-Erie or Bucyrus-Armstrong drill, with drilling equipment for 600' to 1000' work. Give particulars and price first letter. J. B. Longstreet, Box 63, Matheson, Ontario, Canada.

FOR SALE: Peerless Hi-Lift pump, 30 gpm, 5 H.P. single-phase, approximately 250 ft. stainless steel shafting, used one week. Cost $2,000. Sell for $950. Located in New England. Marvin Ayre, Box 3191, Fort Lauderdale, Florida.

WANTED: Bucyrus-Erie 22W drilling machine; truck mounted, trailer mounted or unmounted. Also slim-hole rotary drill for 1,000 to 1,500-foot work, complete with tools. Adolph Rude, Flandreau, South Dakota.

FOR SALE: Solid derrick for Bucyrus-Erie 20-W. 32' long, with all sheaves and rubber mounting. Martell Bros., Somerset, Wisconsin.

FOR SALE: Star #240 drilling machine; string of tools for 4-inch work and string for 5 and 6-inch work; complete, with wrenches and jacks. Price, $3,000. Perkins Well Drilling, 1017 Summit Avenue, St. Paul Park, Minnesota. Phone: La Salle 2608.

FOR SALE: Dempster No. 15 cable tool drill with IHC 6-cylinder motor mounted on two-ton White truck; 30-foot wood mast; for 1,000-foot work, set of jars; 4", 5" and 7" bits; 4" 12' bailer; ½" drill line and ⅜" sand line. Excellent condition. Price, $1,500. D. E. Stupka, Stratton, Nebraska.

FOR SALE: Ideco drilling machine, mounted on Mack truck. Price, with tools, $5,000. Henry Merry, Franklin Street, Duxbury, Massachusetts.

FOR SALE: 1951 Ideco #10 drilling machine, mounted on 1941 Dodge cab-over-engine truck, with 2-speed axle. Excellent condition. Telescoping derrick with power lift; cat-heads; electric starter; built-in tool box. Also 800' of nearly new ⅝" drill line and 700' of sand line. Andy Verwers, Lynnville, Iowa.

FOR SALE: Bucyrus-Erie 21 drill, mounted on Diamond-T truck. Very good condition. Price, $2,100. Box APS c/o Edward E. Johnson, Inc., 2304 Long Avenue, St. Paul 14, Minnesota.

FOR SALE: Keystone #70 drilling machine, mounted on 1942 truck. 1,000' of ⅝" drill cable; 4" and 6" tools; set of jars; wrenches; drive clamps. Price, $1,800. Joseph E. Ellis, Route 2, Box 252C, Orlando, Florida. Phone: 39543.

WANTED: Power well auger, with engine drive. State price and condition first letter. Julius Ford, 633 W. Chase Street, Macomb, Illinois.

FOR SALE: Keystone, all-steel, extension-mast spudder, mounted on 1948 International truck; with heavy-duty power winch. Machine completely overhauled 1953. With or without tools, for 4" to 10" wells. Charles Appleby, 192 Liberty Street, Warsaw, New York. Phone: 118-R.

Artesian well 700 feet deep cased with 6-inch pipe, flowing 670 gpm. Drilled for the village of Karpur Daslara. A State-owned cable tool drill and crew did the work. This crew, plus several others, are supervised by Errol A. Gore, drilling engineer, standing near the machine.

FOR SALE: Bucyrus-Erie 22-W drill, mounted on 1937 International DS 30 truck; with power derrick hoist, casing reel, catheads, spooling device. Excellent condition. Drilling and fishing tools for 6" to 18" wells. Priced to sell at one-third cost. Selling due to ill health. L. F. Bales, 111 West Walnut, Sayre, Oklahoma. Phone: 867.

FOR SALE: No. 35 Armstrong drill on semi-trailer with International truck; tools and cable; price $1,000. Leonard Shilhanek, Tama, Iowa.

FOR SALE: No. 24 Bucyrus-Erie drilling machine mounted on truck; in very good condition. Priced to sell. Hoeg and Ames, Lincoln, Iowa.

FOR SALE: No. 24W Bucyrus-Erie drill with 42' derrick and power hoist on 3½-ton Diamond T truck; equipped with cat-heads, casing reel, starter. Write Box ESW, Edward E. Johnson, Inc., 2304 Long Avenue, St. Paul 14, Minnesota.

FOR SALE: Used Model #40 Cyclone Drill, mounted on truck; also used Model #42 Cyclone Drill. Both in excellent condition and fairly late model machines. Priced to sell. Sanderson Cyclone Drill Company, Orrville, Ohio.

FOR SALE: Failing 1,000 Holemaster drilling machine, mounted on 1949 Ford V-8 truck; tools, drill pipe, accessories. Also, 1,500 Holemaster heavy-duty. Fred E. Butler, Box 481, Pueblo, Colorado.

FOR SALE: Bucyrus-Erie Model 21-W drilling machine, A-1 condition, with 1939 Chevrolet truck; 300' of ⅝" cable and 400' of ⅜" sandline. Machine recently repainted and engine overhauled. Price $2,700. George Brunner, Medford, Wisconsin. Phone: 5482.

FOR SALE: One Ferguson drilling machine, in good shape, eccentric drop-tool; will drill to 600 feet. Price $800. Miss Virginia J. Slaton, Box 163, Bokchito, Oklahoma.

FOR SALE: No. 50 Keystone drill mounted on 3-ton 1942 GMC truck, all A-1 shape; has magneto ignition, starter and generator; calf line, 900' of ⅝" drill cable; 900' of ⅜" sand line. Harold Adams, Marengo, Iowa.

FOR SALE: Ferguson water-well drill, with eccentric drop tool, in good condition. Machine has capacity to 200 feet. Price $600. Miss Virginia J. Slaton, Box 163, Bokchito, Oklahoma.

FOR SALE: Fishing jars, 4⅞" bit, combination socket, spear, friction socket and heavy duty elevators. Two 4" bits and 4" elevator. Miscellaneous items including sand buckets, jack, tongs, pipe dies, and subs, at about half of new price. Twelve new 12" B-E shock absorber discs, $35; and 300' of ¾" drill line, used on one well, $50. One 5¾" x 60" pump cylinder. Ed. Feyh, 3219 Bellefontaine, Kansas City, Missouri.

FOR SALE: Mayhew 1000 drill mounted on 1948 GMC. Failing 1500 drill mounted on 2½-ton GMC. Failing 1000 drill on V-8 truck. Fred E. Butler, Box 481, Pueblo, Colorado.

POSITION WANTED: Young, energetic, highly experienced well drilling engineer and assistant want drilling work outside India. Wish to improve experience with a good firm. Sober habits. Salary open. Employed now as executive engineer and assistant, Tube Well Boring Department, Ahmedabad, India. Have 17 years' experience in use of percussion, core, jet and rotary drills for water and oil wells. Write Errol A. Gore, c/o Edward E. Johnson, Inc., 2304 Long Ave., St. Paul 14, Minnesota.

WANTED: Will buy or rent rotary drilling machine, truck mounted, complete with drill pipe. Capable of drilling 6" hole to 500 feet. D. E. Stupka, Stratton, Nebraska.

FOR SALE: Bucyrus-Erie 22 drill, mounted on International truck. Has cat-heads and rubber-cushioned sheaves. Excellent condition; located in Northern Iowa. Price, $4,500. Box APS, c/o Edward E. Johnson, Inc., 2304 Long Avenue, St. Paul 14, Minnesota.

FOR SALE: Cook double-acting 8" pump, 18" stroke, 100-foot setting. Size 2-L, 15 HP, 1160 rpm, 440 V. A-1 condition. Polor Ice Company, Decatur, Illinois.

WANT TO TRADE: 1954 modern Richardson house trailer for 20-W Bucyrus-Erie or comparable drilling machine. Dee Linn, Morganton, Arkansas.

FOR SALE: Two number 10-W Ideco drills, mounted on trucks; set of 4" and 5" tools with each machine. Price, $3,500 each. John Hufker, 8831 W. 95th Street, Oak Lawn, Illinois. Phone: Garden 4-1625.

WANTED: Used drill collars for Failing 1500 drill. Give size, length, and price, first letter. Sydney Earl, Kerrwood, Ontario, Canada.

FOR SALE: Rotary drilling machine, with 17¼ rotary, Emsco 100-tone swivel, 55-foot 100-ton telescoping derrick. Portable, for quick moving and set-up. Complete with tools, pipe and lighting plant. Garner-Denver 7¼ x 10 mud pump with 180 HP Climax engine, mounted and carried on 10-ton, 10-wheel truck. Can be purchased with or without pipe and truck. Will trade or rent. American Drilling Company, 674 Branch Avenue, Little Silver, New Jersey.

WANTED: Star #71 drilling machine, with calf reel. Complete with tools. Would like to purchase from person west of Minnesota. R. Gordon Downey, Box 142, Duncan, B. C., Canada.

FOR SALE: Mobile dry-hole auger. Capacity: 5" hole to 100'. Will trade for larger rotary or cable tool drill. Elmer Crain, Boyne City, Michigan.

WANTED: Failing 1500 or similar drilling machine. Also, Bucyrus-Erie 20W or similar cable tool drill. Elmer Crain, Boyne City, Michigan.

WANTED: Bucyrus-Erie 20, 21W or Ideco drilling machine. Give condition and price first letter. O. E. Lewis, Darlington, Indiana.

FOR SALE: Bucyrus-Erie 22W drill, truck mounted, in good condition. Price, $4,000. No. 35, all-steel, Armstrong machine, trailer mounted. Practically new International Engine. Price, $1,000. Bonnicksen & Son, Ringsted, Iowa.

Sixteen-inch, naturally developed well, 75 feet deep at Eau Claire, Wisconsin, being test-pumped at 2,000 gpm. Water is completely sand free.

DON'T MISS THESE POINTS!

If you use flush or drive points in your wells

If you want to get all of the water the vein will give

If you have trouble with corrosion or cementing-over of screens

If you want to keep your customers happy and build a reputation for high grade work

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96 per cent copper and strong as ordinary steel. A remarkable metal that can be driven and will last a lifetime, under most conditions.

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Type 304 "18-8" — a really high grade corrosion-resisting stainless steel. It's tough and strong for service where harder driving is necessary.

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